Analemma-sundial combination sculpture

Wally Motloch (Santa Cruz, CA)

A few years ago, as I was reading about celestial motion and sundials, the idea of designing and fabricating my own sun calculator/indicator seemed like a very good project for a retired person. I set some objectives for myself:

- I wanted it to work in a unique way: my way.
- The sculpture needed to tell the time, the day, and the month, and do all this without gears, weights or batteries!
- I wanted it to look old, as if it came from the Middle Ages.
- And, as a side project, I wanted to verify the sun's path for myself, using photographs I took at noon almost every day for a year.

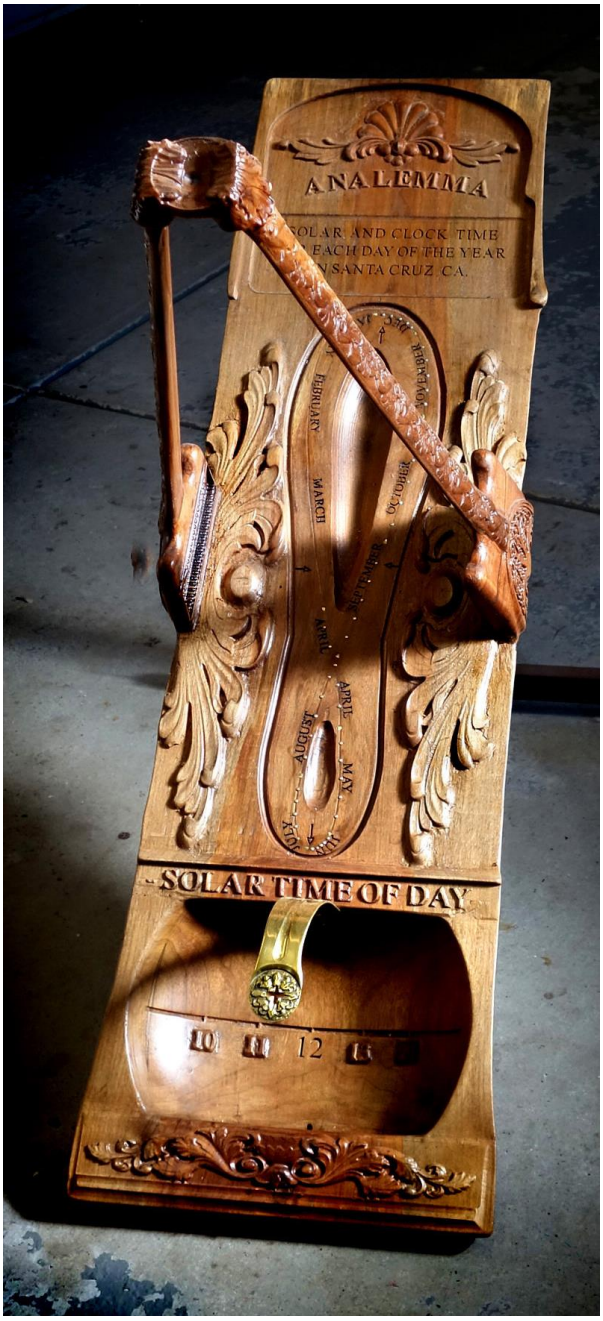

Fig.1 The finished Analemma-Sundial Sculpture.

Introduction.

Due to Earth's inclined axis of rotation and the fact that it orbits the sun in oval trajectory, viewing the sun from Earth at exactly the same time each day creates some interesting geometry. A graph of the Sun's daily position in the sky at a chosen clock time over a year is referred to as an Analemma. According to the season, each day the sun's path shifts up or down a little in the sky. If you start on the day of the Spring Equinox (March 21 in the Northern Hemisphere) it moves up till Summer Solstice, the longest day (June 21). After that it will move down, through Fall Equinox (September 21), to reach the lowest position at the Winter Solstice, the shortest day (December 21).

Now, the Analemma gets fat or skinny depending on how far you are from the equator. That is the reason why I wanted to generate the shape of it for latitude.

Picture taking

To start on this project, I needed to produce the shape of an analemma for my location in Santa Cruz, California. Taking pictures of the sun and collecting data is no small undertaking. Having an interest in photography helped me because one needs to know a lot of details in order to point the camera directly at the sun and get useful images for planned photomontage. All pictures need to be taken from the same location and exactly the same clock time for a period of an entire year.

Fig. 2. The camera and plywood support that fits snugly in the window frame to ensure repeatable and precise locating of the camera's view. My lovely wife Lillian is preparing to take a photo of the sun.

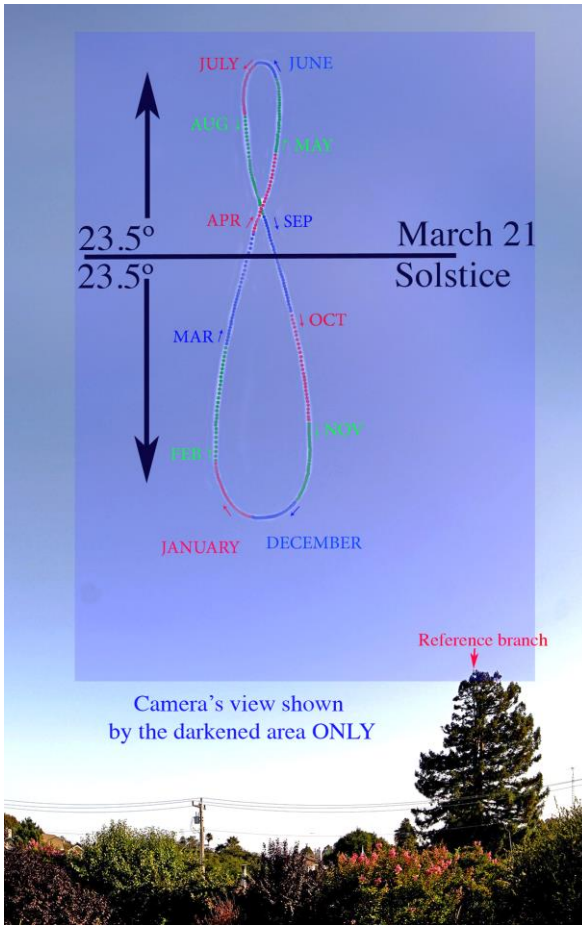

Fig. 3 Shows view out of the window. The camera's frame only sees the reference branch and the area above it, as indicated by the shading area of the photo.

You will need a dedicated camera with a wide-angle lens and lots of neutral density filters to protect the sensor from damage. The camera needs to be stored indoors when not used, so its position and orientation must be exactly indexed and be repeatable. Later, images are edited together in Photoshop (for example) to create a figure of eight shape. Because the sun disk is large, it was necessary to find the center of each disk and use only 4 pixels of it to mark the path in the layout.

I was fortunate to have a south-facing window and a tall tree in my view so that top branches could be used as a reference for all the pictures. I started on March 21, Solstice day, because I knew that the sun would travel up and down from that point and that the images would fit in my camera frame.

I live in Santa Cruz, California, where the weather is conducive to this kind of project. Out of 365 days there were almost 300 good pictures to use for the layout. We used an iPad to get the precise time and at exactly the same instant every day (12:00 in the winter and 13:00 in the summer), either my wife or I would take the picture.

Layout for CNC and carving the wood

My good neighbor Linc cut down a walnut tree a few years ago and was kind enough to give me sections of the trunk, split to create half-rounds of about 5 feet long. These were drying and waiting for a project. As it turned out, one was perfect for my Analemma Project.

The sculpture was therefore laid out to suit this piece of wood and after a few drawings, I was ready to start modeling details of the design using the Aspire software, produced by Vectric Co.

Because my CNC machine was too small for the entire log to fit, I divided the cutting into three separate sections:

- top section for wording about Santa Cruz,
- middle for Analemma design,
- the bottom for the sundial.

After the wood was carved, much time was devoted to cleaning and sanding. Next, the brass arm for the sundial with the cross-slit was fabricated and installed.

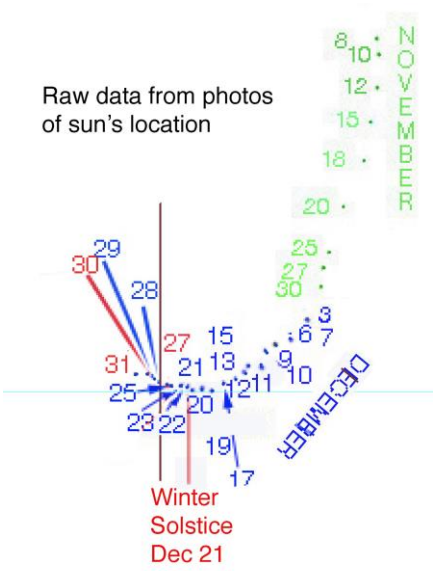

Fig. 4 Plot of raw data. Daily sun dots were manipulated in Photoshop and dates were added.

SOLAR TIME OF DAY
A
Step 1.
As the sun shines through opening A, wait for the mark to hit exactly 12.
At that very moment look for Analemma's mark B on the figure of 8. This mark indicates the day and month of the year.
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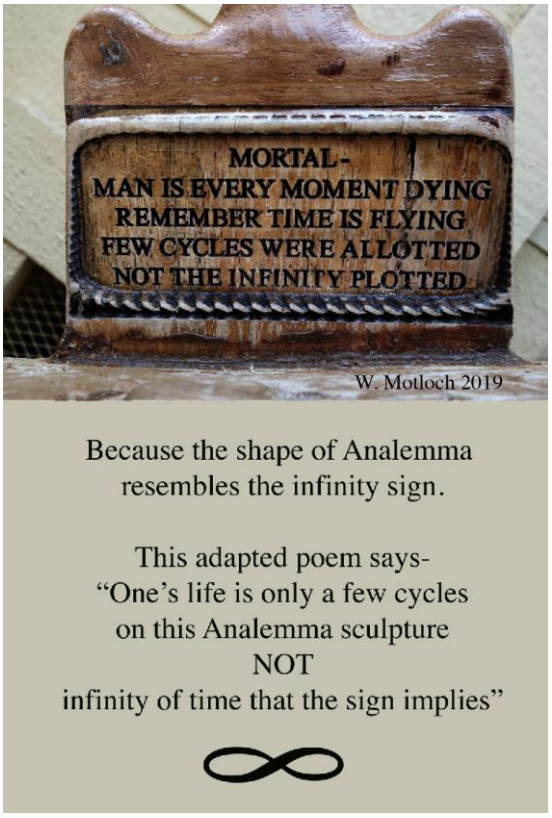
Fig. 5. Detail of sundial, the lower part of the sculpture.

B
ANALEMMA
SOLAR TIME OF DAY
Step 2.
As the sun shines through opening B, at exactly Solar Noon, a bright spot on the sculpture will mark the DAY and the MONTH
W. Motloch 2019

Fig. 6. the Analemma and the structure that supports the pinhole fixture. At the very moment that the sundial indicates noon, one can look for the sunspot on the Figure of 8 to read the day and month.


MORTAL -
MAN IS EVERY MOMENT DYING
REMEMBER TIME IS FLYING
FEW CYCLES WERE ALLOTTED
NOT THE INFINITY PLOTTED
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Because the shape of Analemma resembles the infinity sign.
This adapted poem says-
"One's life is only a few cycles on this Analemma sculpture
NOT
infinity of time that the sign implies"

Fig. 7 Every time-indicating sculpture needs a motto. In this case, because the shape of the analemma resembles thesign for infinity, it was easy to adopt an existing poem to my needs.

The intended message is "Just because it looks like infinity, don't be fooled as only a few cycles down this path, were allotted to each one of us."

The pinhole fixture for the Analemma had to be properly positioned in space and rigidly attached to the wood half-round so that the point of light would travel the path of my figure of eight.

To make all this work, I fabricated a rigid aluminum frame and firmly attached it to the half-round. Later this was veneered with decorated walnut pieces to complete the design.

Readers may notice that the numbers on the sundial do not match. This is a fix, because I made a mistake and had the numbers run in reverse.

Alignment to the sun

The resulting sculpture rested on a support that could be adjusted in three dimensions: the pitch and roll could be adjusted with long threaded screws and the whole assembly could be rotated to find the Solar Noon at my location, 36°58′ N, 121°59′ W.

After a year and a half of work, there it was, working in the sun. My neighbors could come over at noon and as the sundial reached 12, they could look at the analemma and tell day and month - I felt like the mission was accomplished; it was a thing of beauty!

Epilog

I had dreams it would last a long time, but the sun said otherwise. After a few months in the sun, my sculpture deteriorated greatly. The same sun that gave me information also completely destroyed the varnish and cracked the wood in many places. The shine of brass and beauty were lost, and the sculpture looked ruined.

As I write this, I am looking for ways to use the sculpture as a mold to cast and reproduce this design in concrete. This way, the cement can defend itself from the all-destroying sun. I would welcome comments and suggestions.

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Related publications

Examples of my CNC work: https://www.vectric.com/vectric-community/case-study/WallyMotloch

Hansen's Star Map And The Precession Of The Equinoxes Circle: https://grahamhancock.com/motlochw1/

St. Matthew Lutheran Church. Hawthorn Woods, IL.

By John Carmichael and Mike Forbes.

Sundial Registry #876.